

Technical Approaches to Characterizing and Cleaning up Brownfields Sites:

Railroad Yards

Site Profile
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Notice

The U.S. Environmental Protection Agency through its Office of Research and Development funded and managed the research described here under Contract No. 68-C7-0011 to Science Applications International Corporation (SAIC). It has been subjected to the Agency's peer and administrative review and has been approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Foreword

The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce risks in the future.

The National Risk Management Research Laboratory is the Agency's center for investigation of technological and management approaches for reducing risks from threats to human health and the environment. The focus of the Laboratory's research program is on methods for the prevention and control of pollution to air, land, water, and subsurface resources; protection of water quality in public water systems, remediation of contaminated sites and groundwater; and prevention and control of indoor air pollution. The goal of this research is to catalyze development and implementation of innovative, cost-effective environmental technologies; develop scientific and engineering information needed by EPA to support regulatory and policy decisions; and provide technical support and information transfer to ensure effective implementation of environmental regulations and strategies.

This publication has been produced as part of the Laboratory's strategic long-term research plan. It is published and made available by EPA's Office of Research and Development to assist the user community and to link researchers with their clients.

E. Timothy Oppelt, Director
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Chapter 1

Introduction

Background

Many communities across the country have brownfields sites, which the U.S. Environmental Protection Agency (EPA) defines as abandoned, idle, and under-used industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination. Concerns about liability, cost, and potential health risks associated with brownfields sites may prompt businesses to migrate to "greenfields" outside the city. Left behind are communities burdened with environmental contamination, declining property values, and increased unemployment. The EPA established the Brownfields Economic Redevelopment Initiative to enable states, site planners, and other community stakeholders to work together in a timely manner to prevent, assess, safely clean up, and sustainably reuse brownfields sites.

The cornerstone of EPA's Brownfields Initiative is the Brownfields Pilot Program. Under this program, EPA is funding more than 200 brownfields assessment pilot projects in states, cities, towns, counties, and tribal lands across the country. The pilots, each funded at up to \$200,000 over two years, are bringing together community groups, investors, lenders, developers, and other affected parties to address the issues associated with assessing and cleaning up contaminated brownfields sites and returning them to appropriate, productive use. In addition to the hundreds of brownfields sites being addressed by these pilots, many states have established voluntary cleanup programs to encourage municipalities and private sector organizations to assess, clean up, and redevelop brownfields sites. The EPA has a website where information on brownfields redevelopment can be found. The address is www.epa.gov/brownfields.

Purpose

EPA has developed a set of technical guides, including this document, to assist communities,

states, municipalities, and the private sector to better address brownfields sites. Currently, six guides in the series are available:

- *Technical Approaches to Characterizing and Cleaning up Iron and Steel Mill Sites under the Brownfields Initiative*, EPA/625/R-98/007, December 1998.
- *Technical Approaches to Characterizing and Cleaning up Automotive Repair Sites under the Brownfields Initiative*, EPA/625/R-98/008, December 1999.
- *Technical Approaches to Characterizing and Cleaning Metal Finishing Sites under the Brownfields Initiative*, EPA/625/R-98/006, December 1999.
- *Technical Approaches to Characterizing and Cleaning up Brownfields Sites*, EPA/625/R-00/009, December 2000.
- *Technical Approaches to Characterization and Cleanup of Automotive Recycling Brownfields*, EPA/625/R-02/001, January 2001.
- *Technical Approaches to Characterizing and Redeveloping Brownfields: Municipal Landfills and Illegal Dumps*, EPA/625/R-02/002, January 2002.

These guides are comprehensive documents that cover the key steps to redeveloping brownfields sites for their respective industrial sector. In addition, a supplementary guide contains information on cost-estimating tools and resources for brownfields sites (*Cost Estimating Tools and Resources for Addressing Sites Under the Brownfields Initiative*, EPA/625/R-99/001, January 1999).

EPA developed a general guide (listed above) to provide decision makers with a better understanding of the common technical issues involved in assessing and cleaning up brownfields sites. This industry specific profile supplements that general guide.

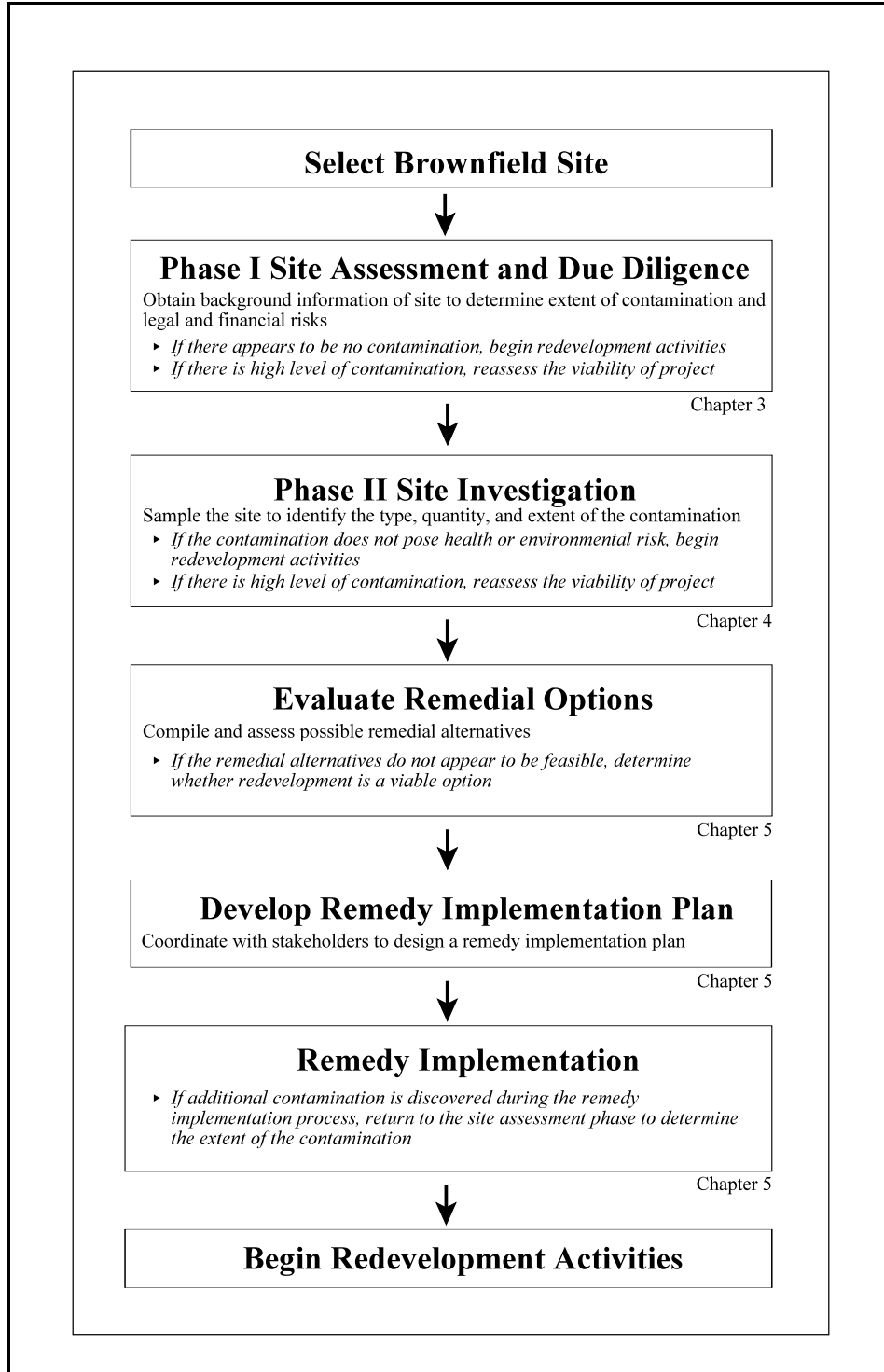


Exhibit 1-1. Flow Chart of the Brownfields Redevelopment Process

Typical Brownfield Redevelopment Process

The typical brownfields redevelopment process begins with a Phase I site assessment and due diligence, as shown in Exhibit 1-1. The site assessment and due diligence process provides an initial screening to determine the extent of the contamination and possible legal and financial risks. If the site assessment and due diligence process reveals no apparent contamination and no significant health or environmental risks, redevelopment activities may begin immediately. If the site seems to contain unacceptably high levels of contamination, a reassessment of the project's viability may be appropriate.

A Phase II site investigation samples the site to provide a comprehensive understanding of the contamination. If this investigation reveals no significant sources of contamination, redevelopment activities may commence. Again, if the sampling reveals unacceptably high levels of contamination, the viability of the project should be reassessed.

Should the Phase II site investigation reveal a manageable level of contamination, the next step is to evaluate possible remedial alternatives. If no feasible remedial alternatives are found, the project viability would have to be reassessed. Otherwise, the next step would be to select an appropriate remedy and develop a remedy implementation plan. Following remedy implementation, if additional contamination is discovered, the entire process is repeated.

Organization of this Document

This document is organized as follows:

- Chapter 2 – Railroad Yard Brownfields
- Chapter 3 – Phase I Site Assessment and Due Diligence
- Chapter 4 – Phase II Site Investigation
- Chapter 5 – Contaminant Management
- Chapter 6 – Conclusion
- Appendix A – Acronyms
- Appendix B – Glossary
- Appendix C – Testing Technologies
- Appendix D – Cleanup Technologies
- Appendix E – Works Cited

Chapter 2

Railroad Yard Brownfields

On February 28, 1827, the State of Maryland chartered the Baltimore & Ohio (B&O) Railroad. This was the beginning of the nation's rail system. Since then, the railroad industry has laid over 300,000 miles of railroad track, connecting almost every locale, rural or urban, throughout the United States. When railroad lines meet industrial areas, railroad yards result. Railroad yards are areas where railcars and locomotives are maintained, stored, and coupled to form trains. Rail yards are in effect the "garage" of rail lines, a central location in a region where railroad companies can work on their rolling stock and dispatch trains to locations around the country. Almost any large town or city, especially ones with industry, are likely to have a rail yard of some size. The smallest ones can be as simple as track sidings where rail cars can be stored until needed, while the largest ones can be in the hundreds of acres. (EPA 1997).

Today, railroads are experiencing a decline, as trucks out-compete railroads for freight traffic. As a result, more and more rail yards are laying unused or closed. These rail yards many times qualify as "brownfields".

This section discusses railroad yards, the typical types of contaminants that can be found at a site, and possible remediation strategies.

Railyard Activities

A wide variety of activities take place at a railroad yard that can result in environmental problems. These activities can be broken down into roughly four areas (EPA August, 1999). These areas are:

- Locomotive maintenance
- Railcar refurbishing and maintenance
- Track maintenance
- Transportation operations

Locomotive Maintenance

There are numerous activities associated with locomotive maintenance that can result in environmental problems. Activities that may have contributed contaminants to the area in the past are: changing oil and oil filters, painting and paint stripping, hydraulic system repair, locomotive coolant disposal, metal machining, used battery disposal and general cleaning of engine parts and the locomotive car (EPA 1997). Asbestos can be present from the insulation around the boilers of steam locomotives, old structures, or from old brake shoes that were not properly disposed of. Brake repair, large- and small-scale equipment cleaning, and metal machining can be part of maintenance. Each of these activities can contribute to environmental problems.

➤ Railcar Refurbishing and Maintenance

Railcar refurbishing and maintenance consist of cleaning the interiors and exteriors of the railcars, stripping and painting the railcars, and other maintenance such as brake and wheel set repair (EPA 1997). Environmental problems can result from all these activities. In addition, anything that the railcars carry or pass over (i.e., creosote) may wash off and contaminate the surrounding soil or water.

Refurbishing railcars entails the removal of old paint and the application of new paint. Both of these activities can result in soil or water contamination. The paint removal process can result in paint chips and grit. These chips and grit can cause soil or water contamination. When the new paint is applied there is also the chance that some of the new paint could end up in the surrounding soil or water. Exhibit 2-1 lists the processes, material

inputs and wastes associated with railcar refurbishing and maintenance.

➤ **Track Maintenance**

Environmental problems from track maintenance can result from two areas. First, the wood ties are treated with a wood preserver such as creosote, which can leach into the soil and groundwater. Second, the gravel and stone mixtures upon which the tracks are built usually contain heavy metals. These heavy metals tend to be from the stone mixture or “slag”, which is often the residual left over from copper mining. These can also leach into surrounding soil and groundwater (EPA 1999).

➤ **Transportation Operations**

Transportation operations can create environmental problems from three areas: fueling, hazardous material transport, and oil and coolant release during transport (EPA 1997). With fuel operations there can be spillage or fuel leakages. It is also important to determine if the fuel storage tanks and piping were above ground or below ground. If the tanks and piping were below ground there could be an increased chance of groundwater contamination.

➤ **Associated Industrial Activities**

Other industries, such as tank car cleaning, have frequently grown up around the rail industry. There may be contamination from these kinds of activities. Also, while hazardous wastes from the site are usually drummed and shipped off site, there may be unidentified waste-containing drums left at the site. Therefore, the areas and buildings surrounding the railyard may need to be considered.

Contaminants Found at Railyards

Various types of contaminants can result from the railroad yard operations described above. Each contaminant is a risk to both soil and groundwater quality.

Contaminants resulting from locomotive and engine maintenance are degreasing solvents, PCBS (poly-chlorinated biphenyls), and heavy metals. Solvents and heavy metal-based paints can be found in the area surrounding railcar refurbishing and maintenance operations. Further environmental problems can result from creosote and Pentachlorophenol (PCP) from the rail ties. The “slag” base for the railroad ties can contribute to heavy-metal contamination. Finally, contamination from the transportation operations can be from diesel fuel associated with fueling as well as possible contamination from spillage or leakage of hazardous cargo during transport.

Typical Contaminants Found at a Railroad Yard

- Petroleum Hydrocarbons
- waste acids and alkalis
- paints contaminated with heavy metals
- VOCs
- BTEX
- Solvents and paint thinners
- Fuels
- Oil and grease
- Lead
- PCBs
- used coolants

“Guide to Contaminants Found at Typical Brownfields Sites, Appendix A.” Undated.
<http://clu-in.org/PRODUCTS/ROADMAP/appenda.htm>.

Exhibit 2-1. Typical Railyard Contaminants

Railyard Site Remediation

Remediation of railyards depends, as with any other brownfield, on the contaminants present, their concentration, and the media they are affecting (soil or water). In addition, selecting a remediation strategy also involves an in-depth analysis of the costs associated with development. For ease of discussion, we will group the remediation strategies by media to be treated.

Soil Remediation

There are two major classes of soil remediation; ex situ, where soil is removed off site for treatment, and in situ, where soil is treated on site. For the most part, any technique that is performed on site can be performed off site, and vice-versa. Some soil treatment techniques include:

- ▶ **Bioremediation**

This remediation strategy involves using microorganisms such as bacteria, yeast, or fungi to break down hazardous substances to less-toxic or non-toxic substances.

- ▶ **Phytoremediation**

For sites where it is appropriate, phytoremediation may be used both to remove contaminants and to establish greater confidence on the part of the community.

- ▶ **Thermal Desorption**

Thermal desorption is a remediation technique that can be performed on contaminated soils, both in-situ and ex-situ. In this process, soils are heated to temperatures up to 1000°F to break down and destroy contaminants. The volatilized contaminants are then collected and treated by a registered waste disposal facility. This treatment technology works best on compounds with high VOCs and PAHs.

- ▶ **Soil Vapor Extraction (SVE)**

In this remediation technique the soil is usually excavated and moved ex-situ, but it can sometimes be treated in-situ. The method involves exerting a vacuum through the soil formation to extract vapors. It is especially valuable for treating soils with high levels of VOCs and SVOCs.

Groundwater Remediation

- ▶ **Treatment Walls**

This passive remediation strategy is very popular at sites where the hazard is not acute (thus not warranting more expensive methods) but where groundwater contamination needs to be contained. Construction involves excavating a trench perpendicular to the direction of groundwater flow and installing a wall made of a material with the ability to absorb contaminants while letting water flow through naturally. This strategy is only for contaminated groundwater.

- ▶ **Groundwater Extraction/Injection**

This method of treating contaminated groundwater involves drilling numerous wells into and around contaminated groundwater. Once completed, the wells can extract contaminated water for treatment. Treated water is then reinjected into the aquifer. This method of treatment can take years to work, depending on the size of the aquifer, because groundwater withdrawal/injection rates must be monitored closely so as not to cause ground subsidence or other hydrogeological problems. This technique can be used to treat most groundwater problems, including heavy metal and VOC contamination.

Each site will have a unique set of contaminants and those contaminants will be present in unique concentrations. Successful remediation depends on the ability of the developers to create unique treatment plans for that site, while observing any economic constraints.

Chapter 3

Phase I Site Assessment and Due Diligence

Background Information

This portion of the guide is more general and is put here in case a user does not have the general document. Each portion of the information is relevant to railroad yards, and should be considered in their redevelopment.

Site assessment and due diligence provide initial information regarding the feasibility of a brownfields redevelopment project. A site assessment evaluates the health and environmental risks of a site and the due diligence process examines the legal and financial risks. These two assessments help the planner build a conceptual framework of the site, which will develop into the foundation for the next steps in the redevelopment process.

Site assessment and due diligence are necessary to fully address issues regarding the environmental liabilities associated with property ownership. Several federal and state programs exist to minimize owner liability at brownfields sites and facilitate cleanup and redevelopment. Planners and decision makers should contact their state environmental or regional EPA office for further information.

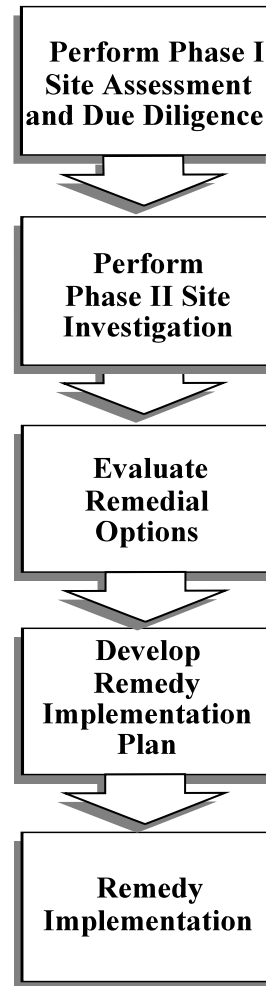
The Phase I site assessment is generally performed by an environmental professional. Cost for this service depends upon size and location of the site, and is usually around \$2,500. A site assessment typically identifies:

- ▶ Potential contaminants that remain in and around a site;
- ▶ Likely pathways through which the contaminants may move; and
- ▶ Potential risks to the environment and human health that exist along the migration pathways.

Due diligence typically identifies:

- ▶ Potential legal and regulatory requirements and risks;
- ▶ Preliminary cost estimates for property purchase, engineering, taxation and risk management; and
- ▶ Market viability of redevelopment project.

This chapter begins with background information on the role of the EPA and state government in



brownfields redevelopment. The remainder of the chapter provides a description of the components of site assessment and the due diligence process.

Role of EPA and State Government

A brownfields redevelopment project is a partnership between planners and decision makers (both in the private and public sector), state and local officials, and the local community. State environmental agencies are often key decision makers and a primary source of information for brownfields projects. In most cases, planners and decision-makers need to work closely with state program managers to determine their particular state's requirements for brownfields development. Planners may also need to meet additional federal requirements. While state roles in brownfields programs vary widely, key state functions include:

- ▶ Overseeing the brownfields site assessment and cleanup process, including the management of voluntary cleanup programs;
- ▶ Providing guidance on contaminant screening levels; and
- ▶ Serving as a source of site information, as well as legal and technical guidance.

The EPA works closely with state and local governments to develop state Voluntary Cleanup Programs (VCP) to encourage, assist, and expedite brownfields redevelopment. The purpose of a state VCP is to streamline brownfields redevelopment, reduce transaction costs, and provide liability protection for past contamination. Planners and decision-makers should be aware that state cleanup requirements vary significantly; brownfields managers from state agencies should be able to clarify how their state requirements relate to federal requirements.

EPA encourages all states to have their VCPs approved via a Memorandum of Agreement (MOA) whereby EPA transfers control over a brownfields site to that state (Federal Register 97-23831). Under such an arrangement, the EPA does not anticipate becoming involved with private cleanup efforts that are approved by

federally recognized state VCPs (unless the agency determines that a given cleanup poses an imminent and substantial threat to public health, welfare or the environment). EPA may, however, provide states with technical assistance to support state VCP efforts.

To receive federal certification, state VCPs must:

- **Provide for meaningful community involvement.** This requirement is intended to ensure that the public is informed of and, if interested, involved in brownfields planning. While states have discretion regarding how they provide such opportunities, at a minimum they must notify the public of a proposed contaminant management plan by directly contacting local governments and community groups and publishing or airing legal notices in local media.
- **Ensure that voluntary response actions protect human health and the environment.** Examples of ways to determine protectiveness include: conducting site-specific risk assessments to determine background contaminant concentrations; determining maximum contaminant levels for groundwater; and determining the human health risk range for known or suspected carcinogens. Even if the state VCP does not require the state to monitor a site after approving the final voluntary contaminant management plan, the state may still reserve the right to revoke the cleanup certification if there is an unsatisfactory change in the site's use or additional contamination is discovered.
- **Provide resources needed to ensure that voluntary response actions are conducted in an appropriate and timely manner.** State VCPs must have adequate financial, legal, and technical resources to ensure that voluntary cleanups meet these goals. Most state VCPs are intended to be self-sustaining. Generally, state VCPs obtain their funding in one of two ways: planners pay an hourly oversight charge

to the state environmental agency, in addition to all cleanup costs; or planners pay an application fee that can be applied against oversight costs.

- **Provide mechanisms for the written approval of voluntary response action plans** and certify the completion of the response in writing for submission to the EPA and the voluntary party.
- **Ensure safe completion of voluntary response actions** through oversight and enforcement of the cleanup process.
- **Oversee the completion of the cleanup and long-term site monitoring.** In the event that the use of the site changes or is found to have additional contamination, states must demonstrate their ability to enforce cleanup efforts via the removal of cleanup certification or other means.

Performing a Phase I Site Assessment

The purpose of a Phase I site assessment is to identify the type, quantity, and extent of potential contamination at a brownfields site. Financial institutions typically require a site assessment prior to lending money to potential property buyers to protect the institution's role as mortgage holder. In addition, parties involved in the transfer, foreclosure, leasing, or marketing of properties recommend some form of site evaluation. A site investigation should include:¹

- A review of readily available records, such as former site use, building plans, records of any prior contamination events;
- A site visit to observe the areas used for various industrial processes and the condition of the property;

- Interviews with knowledgeable people, such as site owners, operators, and occupants; neighbors; local government officials; and
- A report that includes an assessment of the likelihood that contaminants are present at the site.

A site assessment should be conducted by an environmental professional, and may take three to four weeks to complete. Information on how to review records, conduct site visits and interviews, and develop a report during a site assessment is provided below.

Review Records

A review of readily available records helps identify likely contaminants and their locations. This review provides a general overview of the brownfields site, likely contaminant pathways, and related health and environmental concerns.

Facility Information

Facility records are often the best source of information on former site activities. If past owners are not initially known, a local records office should have deed books that contain ownership history. Generally, records pertaining specifically to the site in question are adequate for site assessment review purposes. In some cases, however, records of adjacent properties may also need to be reviewed to assess the possibility of contaminants migrating from or to the site, based on geologic or hydrogeologic conditions. If the brownfields property resides in a low-lying area, in close proximity to other industrial facilities or formerly industrialized sites, or downgradient from current or former industrialized sites, an investigation of adjacent properties is warranted.

In addition to facility records, American Society for Testing and Materials (ASTM) Standard 1527 identifies other useful sources of information such as historical aerial photographs, fire insurance maps, property tax files, recorded land title records, topographic maps, local street directories, building department records, zoning/land use

¹ The elements of a site assessment presented here are based in part on ASTM Standards 1527 and 1528.

records, maps and newspaper archives (ASTM, 1997).

State and federal environmental offices are also potential sources of information. These offices may provide information such as facility maps that identify activities and disposal areas, lists of stored pollutants, and the types and levels of pollutants released. State and federal offices may provide the following types of facility level data:

- The state offices responsible for industrial waste management and hazardous waste should have a record of any emergency removal actions at the site (e.g., the removal of leaking drums that posed an "imminent threat" to local residents); any Resource Conservation and Recovery Act (RCRA) permits issued at the site; notices of violations issued; and any environmental investigations.
- The state office responsible for discharges of wastewater to water bodies under the National Pollutant Discharge Elimination System (NPDES) program will have a record of any permits issued for discharges into surface water at or near the site. The local publicly owned treatment works (POTW) will have records for permits issued for indirect discharges into sewers (e.g., floor drain discharges into sanitary drains).
- The state office responsible for underground storage tanks may also have records of tanks located at the site, as well as records of any past releases.
- The state office responsible for air emissions may be able to provide information on potential air pollutants associated with particular types of onsite contamination.
- EPA's Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) of potentially contaminated sites should have a record of any previously reported contamination at or

near the site. For information, contact the Superfund Hotline (800-424-9346).

- EPA Regional Offices can provide records of sites that have released hazardous substances. Information is available from the Federal National Priorities List (NPL); lists of treatment, storage, and disposal (TSD) facilities subject to corrective action under the Resource Conservation and Recovery Act (RCRA); RCRA generators; and the Emergency Response Notification System (ERNS). Contact EPA Regional Offices for more information.
- State environmental records and local library archives may indicate permit violations or significant contamination releases from or near the site.
- Residents who were former employees may be able to provide information on waste management practices. These reports should be substantiated.
- Local fire departments may have responded to emergency events at the facility. Fire departments or city halls may have fire insurance maps² or other historical maps or data that indicate the location of hazardous waste storage areas at the site.
- Local waste haulers may have records of the facility's disposal of hazardous or other wastes.
- Utility records.
- Local building permits.

Requests for federal regulatory information are governed by the Freedom of Information Act

² Fire insurance maps show, for a specific property, the locations of such items as UST's, buildings, and areas where chemicals have been used for certain industrial processes.

(FOIA), and the fulfilling of such requests generally takes a minimum of four to eight weeks. Similar freedom of information legislation does not uniformly exist on the state level; one can expect a minimum waiting period of four weeks to receive requested information (ASTM, 1997).

Identifying Contaminant Migration Pathways

Off site migration of contaminants may pose a risk to human health and the environment. A site assessment should gather as much readily available information on the physical characteristics of the site as possible. Migration pathways, such as soil, groundwater, and air, depend on site-specific characteristics such as geology and the physical characteristics of the individual contaminants (e.g., mobility, solubility, and density). Information on the physical characteristics of the general area can play an important role in identifying potential migration pathways and focusing environmental sampling activities, if needed.

Topographic, soil and subsurface, and groundwater data are particularly important:

Topographic Data. Topographic information helps determine whether the site may be subject to contamination from or the source of contamination to adjoining properties. Topographic information will help identify low-lying areas of the facility where rain and snowmelt (and any contaminants in them) may collect and contribute both water and contaminants to the underlying aquifer or surface runoff to nearby areas. The U.S. Geological Survey (USGS) of the Department of the Interior has topographic maps for nearly every part of the country. These maps are inexpensive and available through the following address:

USGS Information Services
Box 25286
Denver, CO 80225

[\[http://www.mapping.usgs.gov/esic/to_order.html\]](http://www.mapping.usgs.gov/esic/to_order.html)

Local USGS offices may also have topographic maps.

Soil and Subsurface Data. Soil and subsurface soil characteristics determine how contaminants move in the environment. For example, clay soils limit downward movement of pollutants into underlying groundwater but facilitate surface runoff. Sandy soils, on the other hand, can promote rapid infiltration into the water table while inhibiting surface runoff. Soil information can be obtained through a number of sources:

- The Natural Resource Conservation Service and Cooperative Extension Service offices of the U.S. Department of Agriculture (USDA) are also likely to have soil maps.
- Local planning agencies should have soil maps to support land use planning activities. These maps provide a general description of the soil types present within a county (or sometimes a smaller administrative unit, such as a township).
- Well-water companies are likely to be familiar with local subsurface conditions, and local water districts and state water divisions may have well-logging and water testing information.
- Local health departments may be familiar with subsurface conditions because of their interest in septic drain fields.
- Local construction contractors are likely to be familiar with subsurface conditions from their work with foundations.

Soil characteristics can vary widely within a relatively small area, and it is common to find that the top layer of soil in urban areas is composed of fill materials, not native soils. Geotechnical survey reports are often required by local authorities prior to construction. While the purpose of such surveys is to test soils for compaction, bedrock, and water table, general information gleaned from such reports can support the environmental site assessment process. Though local soil maps and other general soil information can be used for screening purposes

such as in a site assessment, site-specific information will be needed in the event that cleanup is necessary.

Groundwater Data. Planners should obtain general groundwater information about the site area, including:

- State classifications of underlying aquifers;
- Depth to the groundwater tables;
- Groundwater flow direction and rate;
- Location of nearby drinking water and agricultural wells; and
- Groundwater recharge zones in the vicinity of the site.

This information can be obtained from several local sources, including water authorities, well-drilling companies, health departments, and Agricultural Extension and Natural Resource Conservation Service offices.

Identifying Potential Environmental and Human Health Concerns

Identifying possible environmental and human health risks early in the process can influence decisions regarding the viability of a site for cleanup and the choice of cleanup methods used. A visual inspection of the area will usually suffice to identify onsite or nearby wetlands and water bodies that may be particularly sensitive to releases of contaminants during characterization or cleanup activities. Planners should also review available information from state and local environmental agencies to ascertain the proximity of residential dwellings, industrial/commercial activities, or wetlands/water bodies, and to identify people, animals, or plants that might receive migrating contamination; any particularly sensitive populations in the area (e.g., children; endangered species); and whether any major contamination events have occurred previously in the area (e.g., drinking water problems; groundwater contamination).

Such general environmental information may be obtained by contacting the U.S. Army Corps of Engineers, state environmental agencies, local

planning and conservation authorities, the U.S. Geological Survey, and the USDA Natural Resource Conservation Service. State and local agencies and organizations can usually provide information on local fauna and the habitats of any sensitive and/or endangered species.

For human health information, planners can contact:

- *State and local health assessment organizations.* Organizations such as health departments, should have data on the quality of local well water used as a drinking water source, as well as any human health risk studies that have been conducted. In addition, these groups may have other relevant information, such as how certain types of contaminants might pose a health risk during site characterization. Information on exposures to particular contaminants and associated health risks can also be found in health profile documents developed by the Agency for Toxic Substances and Disease Registry (ATSDR). In addition, ATSDR may have conducted a health consultation or health assessment in the area if an environmental contamination event occurred in the past. Such an event and assessment should have been identified in the site assessment records review of prior contamination incidents at the site. For information, contact ATSDR's Division of Toxicology (404-639-6300).

- *Local water and health departments.* During the site visit (described below), when visually inspecting the area around the facility, planners should identify any residential dwellings or commercial activities near the facility and evaluate whether people there may come into contact with contamination along one of the migration pathways. Where groundwater contamination may pose a problem, planners should identify any nearby waterways or aquifers that may be impacted by groundwater discharge of contaminated water, including any drinking water wells

downgradient of the site, such as a municipal well field. Local water departments will have a count of well connections to the public water supply. Planners should also pay particular attention to information on private wells in the area downgradient of the facility because they may be vulnerable to contaminants migrating offsite even when the public municipal drinking water supply is not vulnerable. Local health departments often have information on the locations of private wells.

Both groundwater pathways and surface water pathways should be evaluated because contaminants in groundwater can eventually migrate to surface waters and contaminants in surface waters can migrate to groundwater.

Conducting a Site Visit

In addition to collecting and reviewing available records, a site visit can provide important information about the uses and conditions of the property and identify areas that warrant further investigation (ASTM, 1997). During a visual inspection, the following should be noted:

- Current or past uses of abutting properties that may affect the property being evaluated;
- Evidence of hazardous substances migrating on site or off site;
- Odors;
- Wells;
- Pits, ponds, or lagoons;
- Surface pools of liquids;
- Drums or storage containers;
- Stained soil or pavements;
- Corrosion;
- Stressed vegetation;
- Solid waste;
- Drains, sewers, sumps, or pathways for off-site migration; and
- Roads, water supplies, and sewage systems.

Conducting Interviews

Interviewing the site owner, site occupants, and local officials can help identify and clarify the prior and current uses and conditions of the

property. They may also provide information on other documents or references regarding the property. Such documents include environmental audit reports, environmental permits, registrations for storage tanks, material safety data sheets, community right-to-know plans, safety plans, government agency notices or correspondence, hazardous waste generator reports or notices, geotechnical studies, or any proceedings involving the property (ASTM, 1997). Personnel from the following local government agencies should be interviewed: the fire department, health agency, and the agency with authority for hazardous waste disposal or other environmental matters. Interviews can be conducted in person, by telephone, or in writing.

ASTM Standard 1528 provides a questionnaire that may be appropriate for use in interviews for certain sites. ASTM suggests that this questionnaire be posed to the current property owner, any major occupant of the property (or at least 10 percent of the occupants of the property if no major occupant exists), or "any occupant likely to be using, treating, generating, storing, or disposing of hazardous substances or petroleum products on or from the property" (ASTM, 1996). A user's guide accompanies the ASTM questionnaire to assist the investigator in conducting interviews, as well as researching records and making site visits.

Developing a Report

Toward the end of the site assessment, planners should develop a report that includes all of the important information obtained during record reviews, the site visit, and interviews. Documentation, such as references and important exhibits, should be included, as well as the credentials of the environmental professional who conducted the environmental site assessment. The report should include all information regarding the presence or likely presence of hazardous substances or petroleum products on the property and any conditions that indicate an existing, past, or potential release of such substances into property structures or into the ground,

groundwater, or surface water of the property (ASTM, 1997). The report should include the environmental professional's opinion of the impact of the presence or likely presence of any contaminants, and a findings and conclusion section that either indicates that the environmental site assessment revealed no evidence of contaminants in connection with the property, or discusses what evidence of contamination was found (ASTM, 1997).

Additional sections of the report might include a recommendations section for a site investigation, if appropriate. Some states or financial institutions may require information on specific substances such as lead in drinking water or asbestos.

Due Diligence

The purpose of the due diligence process is to determine the financial viability and extent of legal risk related to a particular brownfields project. The concept of financial viability can be explored from two perspectives, the marketability of the intended redevelopment use and the accuracy of the financial analysis for redevelopment work. Legal risk is determined through a legal liability analysis. Exhibit 3-2 represents the three-stage due diligence process.

Market Analysis

To gain an understanding of the marketability of any given project, it is critical to relate envisioned use(s) of a redeveloped brownfields site to the state and local communities in which it is located. Knowing the role of the projected use of the redevelopment project in the larger picture of economic and social trends helps the planner determine the likelihood of the project's success. For example, many metropolitan areas are adopting a profile of economic activity that parallels the profile of the Detroit area dominated by the auto manufacturing industry. New York, Northern Virginia and Washington, for example, are becoming known as telecommunications hubs (*Brownfields Redevelopment: A Guidebook for Local Governments & Communities*, International City/County Management Association, 1997).

Ohio is asserting itself as a plastics research and development center, and even smaller communities, such as Frederick, Maryland, a growing center for biomedical research and technology are marketing themselves with a specific economic niche in mind.

The benefits of co-locating similar and/or complementary business activities can be seen in business and industrial parks, where collaboration occurs in such areas as facility use, joint business ventures, employee support services such as on-site childcare, waste recycling and disposal, and others. For the brownfields redevelopment planner, this contextual information provides opportunities for creative thinking and direction for collaborative planning related to various possible uses for a particular site and their likelihood of success.

The long-term zoning plan of the jurisdiction in which the brownfields site is located provides an important source of information. Location of existing and planned transportation systems is a key question for any redevelopment activity. Observing the site's proximity to other amenities will flesh out the picture of the attraction potential for any given use.

Assessing the historic characteristics of the site that may influence the project is an important consideration at the neighborhood level. Gaining an understanding of the historic significance of a particular building might lead the community developer toward rehabilitation, rather than new construction on the site. Sensitivity regarding local affinities toward existing structures can go far to win a community's support of a redevelopment project.

Understanding what exists and what is planned provides part of the marketability picture. Particularly for smaller brownfields projects, knowing what is missing from the local community fabric can be an equally important aspect of the market analysis. Whether the "hub" of the area's economic life is light industry or an

office complex or a recreational facility, numerous other services are needed to support the fabric of community.

Restaurants and delicatessens, for instance, complement many larger, more central attractions, as do many other retail, service and recreational endeavors. A survey of local residents will inform the planner of local needs.

Financial Analysis

The goal of a financial analysis is to assess the financial risks of the redevelopment project. A Phase I Site Assessment will give the planner some indication of the possible extent of environmental contamination to the site. Financial information continues to unfold with a Phase II Site Investigation. The process of establishing remedial goals and screening remedial alternatives requires an understanding of associated costs. Throughout these processes increasingly specific cost information informs the planner's decision-making process. The planner's financial analysis should, therefore, serve as an ongoing "conversation" with development plans, providing an informed basis for the planner to determine whether or not to pursue the project. Ultimately the plan for remediation and use should contain as few financial unknowns as possible.

While costs related to the environmental aspects of the project need to be considered throughout the process, other cost information is also critical, including the price of purchase and establishment of legal ownership of the site, planning costs, engineering and architectural costs, hurdling zoning issues, environmental consultation, taxation, infrastructure upgrades, and legal consultation and insurance to help mitigate and manage associated risks.

In a property development initiative, where "time is money," scheduling is a critical factor influencing the financial feasibility of any development project. The timeframe over which to project costs, the expected turnaround time for

attaining necessary permit approvals, and the schedule for site assessment, site investigation and actual cleanup of the site, are some aspects of the overall schedule of the project. Throughout the life of the project, the questions: "how much will it cost" and "how long will it take" must be tracked as key interacting variables.

Financing brownfields redevelopment projects presents unique difficulties. Many property transactions use the proposed purchase as collateral for financing, depending upon an appraiser's estimate of the property's current and projected value. In the case of a brownfields site, however, a lending institution is likely to hesitate or simply close the door on such an arrangement due to the uncertain value and limited resale potential of the property. Another problem that the developer may face in seeking financing is that banks fear the risk of additional contamination that might be discovered later in the development process, such as an underground plume of groundwater contamination that travels unexpectedly into a neighboring property. Finally, though recent legislative changes may soften these concerns, many banks fear that their connection with a brownfields project will put them in the "chain of title" and make them potentially liable for cleanup costs (*Brownfields Redevelopment: A Guidebook for Local Governments & Communities*, International City/County Management Association, 1997).

A local appraiser can assist with estimation of property values before and after completion of the project, as well as evaluation of resale potential. Some of the more notable brownfields redevelopment successes have been financed through consortiums of lenders who agree to spread the risk. Public/private financing partnerships may also be organized to finance brownfields redevelopment through grants, loans, loan guarantees, or bonds. Examples of projects employing unique revenue streams, financing avenues, and tax incentives related to brownfields redevelopment are available in *Lessons from the Field, Unlocking Economic Potential with an*

Conduct Due Diligence

Minimize the Legal and Financial Risk of a Brownfields Project

Market Analysis

Determine the market viability of the project by:

- ▶ Developing and analyzing the community profile to assess public consensus for the market viability of the project
- ▶ Identifying economic trends that may influence the project at various levels or scales
- ▶ Determining possible marketing strategies
- ▶ Defining the target market
- ▶ Observing proximity to amenities for location attractions and value
- ▶ Assessing historic characteristics of the site that may influence the project

Financial Analysis

Assess the financial risks of the project by:

- ▶ Estimating cost of engineering, zoning, environmental consultant, legal ownership, taxation, and risk management
- ▶ Estimating property values before and after project development
- ▶ Determining affordability, financing potential and services
- ▶ Identifying lending institutions and other funding mechanisms
- ▶ Understanding projected investment return and strategy

Legal Liability Analysis

Minimize the legal liability of the project by:

- ▶ Reviewing the municipal planning and zoning ordinances to determine requirements, options, limitations on uses, and need for variances
- ▶ Clarifying property ownership and owner cooperation
- ▶ Assessing the political climate of the community and the political context of the stakeholders
- ▶ Reviewing federal and local environmental requirements to assess not only risks, but ongoing regulatory/permitting requirements
- ▶ Evaluating need and availability for environmental insurance policies that can be streamlined to satisfy a wide range of issues
- ▶ Ensuring that historical liability insurance policies have been retained
- ▶ Evaluating federal and local financial and/or tax incentives
- ▶ Understanding tax implications (deductibility or capitalization) of environmental remediation costs

Environmental Key, by Edith Perrin, Northeast Midwest Institute, 1997. Certain states, such as New Jersey, have placed a high priority on brownfields redevelopment, and are dedicating significant state funding to support such initiatives. By contacting the appropriate state department of environmental protection, developers can learn about opportunities related to their particular proposal.

Legal Liability Analysis

The purpose of legal analysis is to minimize the legal liability associated with the redevelopment process. The application and parameters of zoning ordinances, as well as options and limitations on use need to be clear to the developer. The need for a zoning variance and the political climate regarding granting of variances can be generally ascertained through discussions with the local real estate community. Legal counsel can help the developer clarify property ownership, and any legal encumbrances on the property, e.g. rights-of-way, easements. An environmental attorney can also assist the planner/developer to identify applicable regulatory and permitting requirements, as well as offer general predictions regarding the time frames for attaining these milestones throughout the development process. All of the above legal concerns are relevant to any land purchase.

Special legal concerns arise from the process of redeveloping a brownfields site. Those concerns include reviewing federal and local environmental requirements to assess not only risks, but ongoing regulatory/permitting requirements. In recent years, several changes have occurred in the law defining liability related to brownfields site contamination and cleanup. New legislation has generally been directed to mitigating the strict assignment of liability established by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or "Superfund"), enacted by Congress in 1980. While CERCLA has had numerous positive effects, it also represents barriers to redeveloping brownfields, most importantly the unknown liability costs related to uncertainty over the extent

of contamination present at a site. Several successful CERCLA liability defenses have evolved and the EPA has reformed its administrative policy in support of increased brownfields redevelopment. In addition to legislative attempts to deal with the disincentives created by CERCLA, most states have developed voluntary cleanup or similar programs with liability assurances documented in agreements with the EPA (*Brownfields Redevelopment: A Guidebook for Local Governments & Communities*, International City/County Management Association, 1997).

Another opportunity for risk protection for the developer is environmental insurance. Evaluation of the need and availability of environmental insurance policies that can be streamlined to satisfy a wide range of issues should be part of the analysis of legal liability. Understanding whether historical insurance policies have been retained, as well as the applicability of such policies, is also a dimension of the legal analysis.

Understanding tax implications, including deductibility or capitalization of environmental remediation costs, is a feature of legal liability analysis. Also, federal, state or local tax or other financial incentives may be available to support the developer's financing capacity.

Conclusion

If the Phase I site assessment and due diligence adequately informs state and local officials, planners, community representatives, and other stakeholders that no contamination exists at the site, or that contamination is so minimal that it does not pose a health or environmental risk, those involved may decide that adequate site assessment has been accomplished and the process of redevelopment may proceed.

In some cases where evidence of contamination exists, stakeholders may decide that enough information is available from the site assessment and due diligence to characterize the site and

determine an appropriate approach for site cleanup of the contamination. In other cases, stakeholders may decide that additional testing is warranted, and a Phase II site investigation should be conducted, as described in the next chapter.

Chapter 4

Phase II Site Investigation

Background

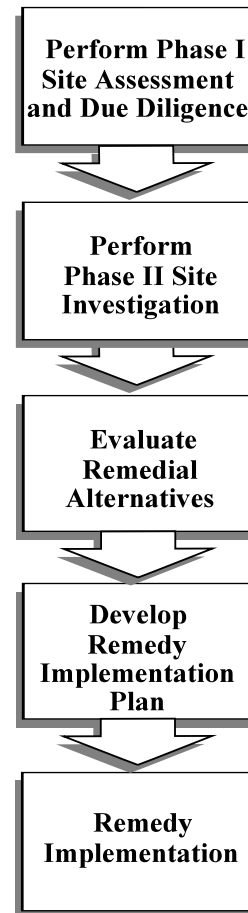
Data collected during the Phase I site assessment may conclude that contaminant(s) exist at the site and/or that further study is necessary to determine the extent of contamination. The purpose of a Phase II site investigation is to give planners and decision-makers objective and credible data about the contamination at a brownfields site to help them develop an appropriate contaminant management strategy. A site investigation is typically conducted by an environmental professional. This process evaluates the following types of data:

- Types of contamination present;
- Cleanup and reuse goals;
- Length of time required to reach cleanup goals;
- Post-treatment care needed; and
- Costs.

A site investigation involves setting appropriate data quality goals based upon brownfields redevelopment goals, using appropriate screening levels for the contaminants, and conducting environmental sampling and analysis.

Data gathering in a site investigation may typically include soil, water, and air sampling to identify the types, quantity, and extent of contamination in these various environmental media. The types of data used in a site investigation can vary from compiling existing site data (if adequate), to conducting limited sampling of the site, to mounting an extensive contaminant-specific or site-specific sampling effort. Planners should use knowledge of past facility operations whenever possible to focus the site evaluation on those process areas where pollutants were stored, handled, used, or disposed of. These will be the areas where potential

contamination will be most readily identified. Generally, to minimize costs, a site investigation begins with limited sampling (assuming readily available data does not adequately characterize the type and extent of contamination on the site) and proceed to more comprehensive sampling if needed (e.g., if the initial sampling could not identify the geographical limits of contamination).



Phase II Site Investigation

Sample the Site to Identify the Type, Quantity, and Extent of the Contamination

Set Data Quality Objectives (DQO)

DQOs are qualitative and quantitative statements specified to ensure that data of known and appropriate quality are obtained. The DQO process is a series of planning steps, typically as follows:

- State the problem
- Identify the decision
- Identify inputs to the decision
- Define the study boundaries
- Develop a decision rule
- Specify limits on decision errors



Establish Screening Levels

Establish an appropriate set of screening levels for contaminants in soil, water, and/or air using an appropriate risk-based method, such as:

- EPA Soil Screening Guidance (EPA/R-96/128)
- Generic screening levels developed by states for industrial and residential use



Conduct Environmental Sampling and Analysis

Conduct environmental sampling and analysis. Typically Site Investigation begins with limited sampling, leading to a more comprehensive effort. Sampling and analysis considerations include:

- A screening analysis tests for broad classes of contaminants, while a contaminant-specific analysis provides a more accurate, but more expensive, assessment
- A field analysis provides immediate results and increased sampling flexibility, while laboratory analysis provides greater accuracy and specificity



Write Report

Write report to document sampling findings. The report should discuss the DQOs, methodologies, limitations, and possible cleanup technologies and goals

Exhibit 4-1. Flow Chart of the Site Investigation Process

Various environmental companies provide site investigation services. Additional information regarding selection of a site investigation service can be found in *Assessing Contractor Capabilities for Streamlined Site Investigations* (EPA/542-R-00-001, January 2000).

This chapter provides a general approach to site investigation; planners and decision-makers should expand and refine this approach for site-specific use at their own facilities.

Setting Data Quality Objectives

While it is not easy, and probably impossible, to completely characterize the contamination at a site, decisions still have to be made. EPA's Data Quality Objectives (DQO) process provides a framework to make decisions under circumstances of data uncertainty. The DQO process uses a systematic approach that defines the purpose, scope, and quality requirements for the data collection effort. The DQO process consists of the following seven steps (EPA 2000):

- *State the problem.* Summarize the contamination problem that will require new environmental data, and identify the resources available to resolve the problem and to develop the conceptual site model.
- *Identify the decision* that requires new environmental data to address the contamination problem.
- *Identify the inputs to the decision.* Identify the information needed to support the decision and specify which inputs require new environmental measurements.
- *Define the study boundaries.* Specify the spatial and temporal aspect of the environmental media that the data must represent to support the decision.
- *Develop a decision rule.* Develop a logical "if ...then ..." statement that defines the

conditions that would cause the decision-maker to choose among alternative actions.

- *Specify limits on decision errors.* Specify the decision maker's acceptable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data.
- *Optimize the design for obtaining data.* Identify the most resource-effective sampling and analysis design for generating data that are expected to satisfy the DQOs.

Please refer to *Data Quality Objectives Process for Hazardous Waste Site Investigations* (EPA 2000) for more detailed information on the DQO process.

Establish Screening Levels

During the initial stages of a site investigation, planners should establish an appropriate set of screening levels for contaminants in soil, water, and/or air. Screening levels are risk-based benchmarks that represent concentrations of chemicals in environmental media that do not pose an unacceptable risk. Sample analyses of soils, water, and air at the facility can be compared with these benchmarks. If onsite contaminant levels exceed the screening levels, further investigation will be needed to determine if and to what extent cleanup is appropriate. If contaminant concentrations are below the screening level, for the intended use, no action is required.

Some states have developed generic screening levels (e.g., for industrial and residential use), and EPA's *Soil Screening Guidance* (EPA/540/R-96/128) includes generic screening levels for many contaminants. Generic screening levels may not account for site-specific factors that affect the concentration or migration of contaminants. Alternatively, screening levels can be developed using site-specific factors. While site-specific screening levels can more effectively incorporate elements unique to the site, developing site-specific standards is a time- and

resource-intensive process. Planners should contact their state environmental offices and/or EPA regional offices for assistance in using screening levels and in developing site-specific screening levels.

Risk-based screening levels are based on calculations and models that determine the likelihood that exposure of a particular organism or plant to a particular level of a contaminant would result in a certain adverse effect. Risk-based screening levels have been developed for tap water, ambient air, fish, and soil. Some states or EPA regions also use regional background levels (or ranges) of contaminants in soil and Maximum Contaminant Levels (MCLs) in water established under the Safe Drinking Water Act as screening levels for some chemicals. In addition, some states and/or EPA regional offices have developed equations for converting soil screening levels to comparative levels for the analysis of air and groundwater.

When a contaminant concentration exceeds a screening level, further site assessment activities (such as sampling the site at strategic locations and/or performing more detailed analysis) are needed to determine whether: (1) the concentration of the contaminant is relatively low and/or the extent of contamination is small and does not warrant cleanup for that particular chemical, or (2) the concentration or extent of contamination is high, and that site cleanup is needed (See Chapter 5, Contaminant Management, for more information.)

Using EPA's soil screening guidance for an initial brownfields investigation may be beneficial if no industrial screening levels are available or if the site may be used for residential purposes. However, it should be noted that EPA's soil screening guidance was designed for high-risk, Tier I sites, rather than brownfields, and conservatively assumes that future reuse will be residential. Using this guidance for a non-residential land use project could result in overly conservative screening levels.

In addition to screening levels, EPA regional offices and some states have developed cleanup levels, known as corrective action levels. If contaminant concentrations are above corrective action levels, a cleanup action must be pursued. Screening levels should not be confused with corrective action levels; Chapter 5, Contaminant Management, provides more information on corrective action levels.

Conduct Environmental Sampling and Data Analysis

Environmental sampling and data analysis are integral parts of a site investigation process. Many different technologies are available to perform these activities, as discussed below.

Levels of Sampling and Analysis

There are two levels of sampling and analysis: screening and contaminant-specific. Planners are likely to use both levels at different stages of the site investigation.

➤ ***Screening.*** Screening sampling and analysis use relatively low-cost technologies to take a limited number of samples at the most likely points of contamination and analyze them for a limited number of parameters. Screening analyses often test only for broad classes of contaminants, such as total petroleum hydrocarbons, rather than for specific contaminants, such as benzene or toluene. Screening is used to narrow the range of areas of potential contamination and reduce the number of samples requiring further, more costly, analysis. Screening is generally performed on site, with a small percentage of samples (e.g., generally 10 percent) submitted to a state-approved laboratory for a full organic and inorganic screening analysis to validate or clarify the results obtained.

Some geophysical methods are used in site assessments because they are noninvasive (i.e., do not disturb environmental media as sampling does). Geophysical methods are commonly used to detect underground objects

that might exist at a site, such as USTs, dry wells, and drums. The two most common and cost-effective technologies used in geophysical surveys are ground-penetrating radar and electromagnetics. Table C-1 in Appendix C contains an overview of geophysical methods. For more information on screening (including geophysical) methods, please refer to *Subsurface Characterization and Monitoring Techniques: A Desk Reference Guide* (EPA/625/R-93003a).

- **Contaminant-specific Sampling.** For a more in-depth understanding of contamination at a site (e.g., when screening data are not detailed enough), it may be necessary to analyze samples for specific contaminants. With contaminant-specific sampling and analysis, the number of parameters analyzed is much greater than for screening-level sampling, and analysis includes more accurate, higher-cost field and laboratory methods. Samples are sent to a state-approved laboratory to be tested under rigorous protocols to ensure high-quality results. Such analyses may take several weeks. For some contaminants, innovative field technologies are as capable, or nearly as capable, of achieving the accuracy of laboratory technologies, which allows for a rapid turnaround of the results. The principal benefit of contaminant-specific analysis is the high quality and specificity of the analytical results.

Increasing the Certainty of Sampling Results

Statistical Sampling Plan. Statistical sampling plans use statistical principles to determine the number of samples needed to accurately represent the contamination present. With the statistical sampling method, samples are usually analyzed with highly accurate laboratory or field technologies, which increase costs and take additional time. Using this approach, planners can consult with regulators and determine in advance specific measures of allowable uncertainty (e.g., an 80 percent level of confidence with a 25 percent allowable error).

Use of Lower-cost Technologies with Higher Detection Limits to Collect a Greater Number of Samples. This approach provides a more comprehensive picture of contamination at the site, but with less detail regarding the specific contamination. Such an approach would not be recommended to identify the extent of contamination by a specific contaminant, such as benzene, but may be an excellent approach for defining the extent of contamination by total organic compounds with a strong degree of certainty.

Site Investigation Technologies

This section discusses the differences between using field and laboratory technologies and provides an overview of applicable site investigation technologies. In recent years, several innovative technologies that have been field-tested and applied to hazardous waste problems have emerged. In many cases, innovative technologies may cost less than conventional techniques and can successfully provide the needed data. Operating conditions may affect the cost and effectiveness of individual technologies.

Field versus Laboratory Analysis

The principal advantages of performing field sampling and field analysis are that results are immediately available and more samples can be taken during the same sampling event; also, sampling locations can be adjusted immediately to clarify the first round of sampling results, if warranted. This approach may reduce costs associated with conducting additional sampling events after receipt of laboratory analysis. Field assessment methods have improved significantly over recent years; however, while many field technologies may be comparable to laboratory technologies, some field technologies may not detect contamination at levels as low as laboratory methods, and may not be contaminant-specific. To validate the field results or to gain more information on specific contaminants, a small percentage of the samples can be sent for laboratory analysis. The choice of sampling and analytical procedures should be based on Data

Quality Objectives established earlier in the process, which determine the quality (e.g., precision, level of detection) of the data needed to adequately evaluate site conditions and identify appropriate cleanup technologies.

Sample Collection Technologies

Sample collection technologies vary widely, depending on the medium being sampled and the type of analysis required, based on the Data Quality Objectives (see the section on this subject earlier in this document). For example, soil samples are generally collected using spoons, scoops, and shovels, while subsurface sampling is more complex. The selection of a subsurface sample collection technology depends on the subsurface conditions (e.g., consolidated materials, bedrock), the required sampling depth and level of analysis, and the extent of sampling anticipated. If subsequent sampling efforts are likely, installing semipermanent well casings with a well-drilling rig may be appropriate. If limited sampling is expected, direct push methods, such as cone penetrometers, may be more cost-effective. The types of contaminants will also play a key role in the selection of sampling methods, devices, containers, and preservation techniques.

Groundwater contamination should be assessed in all areas, particularly where solvents or acids have been used. Solvents can be very mobile in subsurface soils; and acids, such as those used in finishing operations, increase the mobility of metal compounds. Groundwater samples should be taken at and below the water table in the surficial aquifer. Cone penetrometer technology is a cost-effective approach for collecting these samples. The samples then can be screened for contaminants using field methods such as:

- pH meters to screen for the presence of acids;
- Colormetric tubes to screen for volatile organics; and
- X-ray fluorescence to screen for metals.

Tables C-2 through C-4 in Appendix C list more information on various sample collection

technologies, including a comparison of detection limits and costs.

The following chapter describes various contaminant management strategies that are available to the developer.

Chapter 5

Contaminant Management

Background

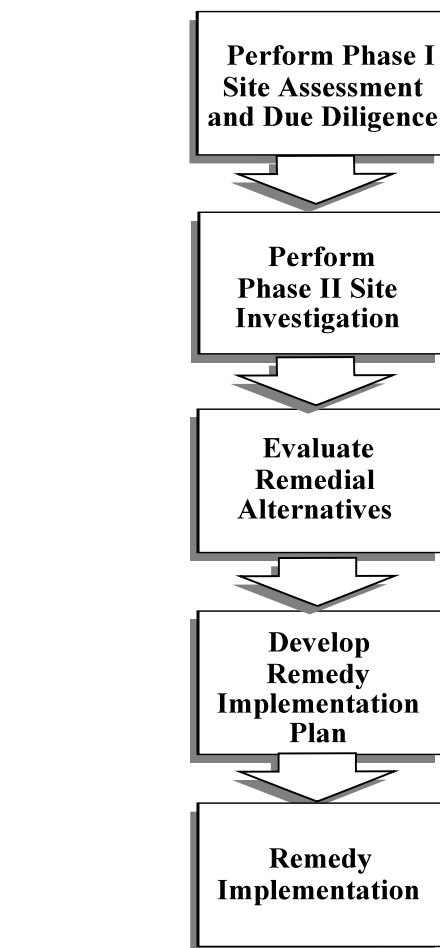
The purpose of this chapter is to help planners and decision-makers select an appropriate remedial alternative. This section contains information on developing a contaminant management plan and discusses various contaminant management options, from institutional controls and containment strategies, through cleanup technologies. Finally, this chapter provides an overview of post-construction issues that planners and decision-makers need to consider when selecting alternatives.

The principal factors that will influence the selection of a cleanup technology include:

- Types of contamination present;
- Cleanup and reuse goals;
- Length of time required to reach cleanup goals;
- Post-treatment care needed; and
- Budget.

The selection of appropriate remedy options often involves tradeoffs, particularly between time and cost. A companion document, *Cost Estimating Tools and Resources for Addressing Sites Under the Brownfields Initiative* (EPA/625/R-99/001 April 1999), provides information on cost factors and developing cost estimates. In general, the more intensive the cleanup approach, the more quickly the contamination will be mitigated and the more costly the effort. In the case of brownfields cleanup, both time and cost can be major concerns, considering the planner's desire to return the facility to reuse as quickly as possible. Thus, the planner may wish to explore a number of options and weigh carefully the costs and benefits of each.

Selection of remedial alternatives is also likely to involve the input of remediation professionals. The overview of technologies cited in this chapter provides the planner with a framework for



seeking, interpreting, and evaluating professional input. The intended use of the brownfields site will drive the level of cleanup needed to make the site safe for redevelopment and reuse. Brownfields sites are by definition not Superfund sites; that is, brownfields sites usually have lower levels of contamination present and, therefore, generally require less extensive cleanup efforts than Superfund sites. Nevertheless, all potential pathways of exposure, based on the intended reuse of the site, must be addressed in the site assessment and cleanup; if no pathways of

exposure exist, less cleanup (or possibly none) may be required.

Some regional EPA and state offices have developed corrective action levels (CALs) for different chemicals, which may serve as guidelines or legal requirements for cleanups. It is important to understand that screening levels (discussed in “Performing a Phase II Site Assessment” above) are different from cleanup (or corrective action) levels. Screening levels indicate whether further site investigation is warranted for a particular contaminant. CALs indicate whether cleanup action is needed and how extensive it needs to be. Planners should check with their state environmental office for guidance and/or requirements for CALs.

Evaluate Remedial Alternatives

If the site investigation shows that there is an unacceptable level of contamination, the problem will have to be remedied. Exhibit 5-1 shows a flow chart of the remedial alternative evaluation process.

Establishing Remedial Goals

The first step in evaluating remedial alternatives is to articulate the remedial goals. Remedial goals relate very specifically to the intended use of the redeveloped site. A property to be used for a plastics factory may not need to be cleaned up to the same level as a site that will be used a school. Future land use holds the key to practical brownfields redevelopment plans. Knowledge of federal, state, local or tribal requirements helps to ensure realistic assumptions. Community surroundings, as seen through a visual inspection will help provide a context for future land uses, though many large brownfields redevelopment projects have provided the catalyst to overall neighborhood refurbishment. Available funding and timeframe for the project are also very significant factors in defining remedial goals.

Developing a List of Options

Developing a list of remedial options may begin with a literature search of existing technologies, many of which are listed in Exhibit D-1 of this

document. Analysis of technical information on technology applicability requires a professional remediation specialist. However, general information is provided below for the community planner/developer in order to support informed interaction with the remediation professional.

Remedial alternatives fall under three categories, institutional controls, containment technologies, and cleanup technologies. In many cases, the final remedial strategy will involve aspects of all three approaches.

Develop Remedy Implementation Plan

The remedy implementation plan, as developed by a professional environmental engineer, describes the approach that will be used to contain and clean up contamination. In developing this plan, planners and decision-makers should incorporate stakeholder concerns and consider a range of possible options, with the intent of identifying the most cost-effective approaches for cleaning up the site, considering time and cost concerns. The remedy implementation plan should include the following elements:

- A clear delineation of environmental concerns at the site. Areas should be discussed separately if the management approach for one area is different than that for other areas of the site. Clear documentation of existing conditions at the site and a summarized assessment of the nature and scope of contamination should be included.
- A recommended management approach for each environmental concern that takes into account expected land reuse plans and the adequacy of the technology selected.
- A cost estimate that reflects both expected capital and operating/maintenance costs.
- Post-construction maintenance requirements for the recommended approach.
- A discussion of the assumptions made to support the recommended management approach, as well as the limitations of the approach.

Evaluate Remedial Alternatives

Compile and Assess Possible Remedial Alternatives for the Brownfields Site

Establish Remedial Goals

Determine an appropriate and feasible remedy level and compile preliminary list of potential contaminant management strategies, based on:

- ▶ Federal, state, local, or tribal requirements
- ▶ Community surroundings
- ▶ Available funding
- ▶ Timeframe



Develop List of Options

Compile list of potential remedial alternatives by:

- ▶ Conducting literature search of existing technologies
- ▶ Analyzing technical information on technology applicability



Initial Screening of Options

Narrow the list of potential remedial alternatives by:

- ▶ Networking with other brownfields stakeholders
- ▶ Identifying the data needed to support evaluation of options
- ▶ Evaluating the options by assessing toxicity levels, exposure pathways, risk, future land use, and financial considerations
- ▶ Analyzing the applicability of an option to the contamination.



Select Best Remedial Option

Select appropriate remedial option by:

- ▶ Integrating management alternatives with reuse alternatives to identify potential constraints on reuse, considering time schedules, cost, and risk factors
- ▶ Balancing risk minimization with redevelopment goals, future uses, and community needs
- ▶ Communicating information about the proposed option to brownfields stakeholders

Exhibit 5-1. Flow Chart of the Remedial Alternative Evaluation Process

Planners and decision-makers can use the framework developed during the initial site evaluation (see the section on "Site Assessment") and the controls and technologies described below to compare the effectiveness of the least costly approaches for meeting the required management goals established in the Data Quality Objectives. These goals should be established at levels that are consistent with the expected reuse plans. Exhibit 5-2 shows the remedy implementation plan development process.

A remedy implementation plan should involve stakeholders in the community in the development of the plan. Some examples of various stakeholders are:

- Industry;
- City, county, state and federal governments;
- Community groups, residents and leaders;
- Developers and other private businesses;
- Banks and lenders;
- Environmental groups;
- Educational institutes;
- Community development organizations;
- Environmental justice advocates;
- Communities of color and low-income; and
- Environmental regulatory agencies.

Community-based organizations represent a wide range of issues, from environmental concerns to housing issues to economic development. These groups can often be helpful in educating planners and decision-makers in the community about local brownfields sites, which can contribute to successful brownfields site assessment and cleanup activities. In addition, state voluntary cleanup programs require that local communities be adequately informed about brownfields cleanup activities. Planners can contact the local Chamber of Commerce, local philanthropic organizations, local service organizations, and neighborhood committees for community input. Representatives from EPA regional offices and state and local environmental groups may be able to supply relevant information and identify other appropriate community organizations. Involving

the local community in brownfields projects is a key component in the success of such projects.

Remedy Implementation

Many of the management technologies that leave contamination onsite, either in containment systems or because of the long periods required to reach management goals, will require long-term maintenance and possibly operation. If waste is left onsite, regulators will likely require long-term monitoring of applicable media (e.g., soil, water, and/or air) to ensure that the management approach selected is continuing to function as planned (e.g., residual contamination, if any, remains at acceptable levels and is not migrating). If long-term monitoring is required (e.g., by the state) periodic sampling, analysis, and reporting requirements will also be involved. Planners and decision-makers should be aware of these requirements and provide for them in cleanup budgets. Post-construction sampling, analysis, and reporting costs can be substantial and therefore need to be addressed in cleanup budgets.

Develop Remedy Implementation Plan

Coordinate with Stakeholders to Design a Remedy Implementation Plan

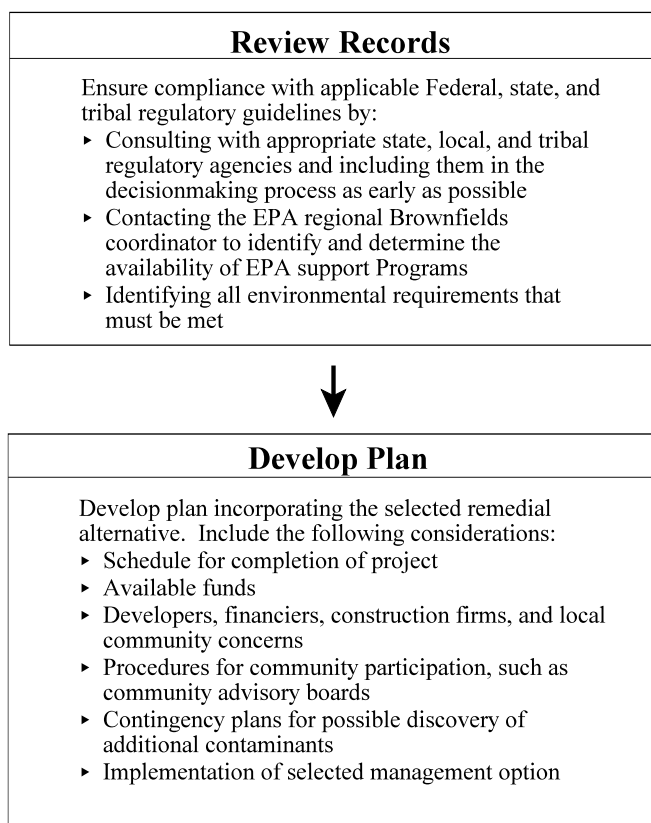


Exhibit 5-2. Flow Chart of the Remedy Implementation Plan Development Process

Chapter 6

Conclusion

Brownfields redevelopment contributes to the revitalization of communities across the U.S. Reuse of these abandoned, contaminated sites spurs economic growth, builds community pride, protects public health, and helps maintain our nation's "greenfields," often at a relatively low cost. This document in conjunction with the General Guide provide an overview of the technical methods that can be used to achieve successful site assessment and cleanup, which are two key components in the brownfields redevelopment process.

This railroad yards site profile provides the technical information necessary to conduct a successful brownfields redevelopment at such a site. However, each site is unique and the specific cleanup activities will be dictated by the site assessment, future use of the site, budget and time frame. Several railroad yards have been redeveloped for other uses. Some of these have been highlighted throughout this document. Users can review internet resources for the most recent redevelopment of railroad yard sites.

To avoid problems throughout the process it is important that stakeholders are involved from the beginning. Consultation with state and local environmental officials and community leaders, as well as careful planning early in the project, will allow planners to develop the most appropriate site assessment and cleanup approaches. Planners should also determine early on if they are likely to require the assistance of environmental engineers. A site assessment strategy should be agreeable to all stakeholders and should address:

- The type and extent of any contamination present at the site;
- The types of data needed to adequately assess the site;
- Appropriate sampling and analytical methods for characterizing contamination; and
- An acceptable level of data uncertainty.

When used appropriately, the process described in this document will help to ensure that a good strategy is developed and implemented effectively.

Once the site has been assessed and stakeholders agree that cleanup is needed, planners will need to consider the cleanup options. Many different types of cleanup technologies are available. The guidance provided in this document on selecting appropriate methods directs planners to base cleanup initiatives on site- and project-specific conditions. The type and extent of cleanup will depend in large part on the type and level of contamination present, reuse goals, and the budget available. Certain cleanup technologies are used onsite, while others require offsite treatment. Also, in certain circumstances, containment of contamination onsite and the use of institutional controls may be important components of the cleanup effort. Finally, planners will need to include budgetary provisions and plans for post-cleanup and post-construction care if it is required at the brownfields site. By developing a technically sound site assessment and cleanup approach that is based on site-specific conditions and addresses the concerns of all project stakeholders, planners can achieve brownfield redevelopment and reuse goals effectively and safely.

